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Combined analysis of visible-near infrared (VNIR), shortwave infrared (SWIR), and longwave infrared (LWIR) imaging spectrometer data

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Abstract: VNIR, SWIR and LWIR imaging spectrometer data are typically analyzed using individual spectral ranges. Integrating modalities to extract complimentary information allows improved characterization and mapping that cannot be accomplished using a single spectral range.

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1. Introduction

Identification of geologic materials using visible to near Infrared (VNIR), shortwave infrared (SWIR), and longwave infrared (LWIR) spectroscopy is well established. This forms the basis for remote measurement using imaging spectrometry (or hyperspectral, "HSI") data. VNIR/SWIR HSI data have been available for over 30 years, and analysis of these for many applications is considered mature. LWIR HSI data, however, have been more difficult to obtain, are only now becoming broadly available, and provide new capabilities that are just being explored. The objective of this research is to improve the accuracy and effectiveness of compositional identification and mapping utilizing the complementary information available from the VNIR-SWIR and LWIR spectral ranges. Analyses of the individual spectral ranges are compared to results from combining and integrating the full-range HSI data.

2. Approach and Methods

VNIR to SWIR HSI radiance data acquired by the Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) and other similar sensors for several sites were converted to reflectance utilizing an atmospheric model [1] and characteristic spectra (endmembers) were extracted using n-Dimensional approaches [2]. Spatially coincident LWIR HSI radiance data from the Spatially Enhanced Broadband Array Spectrograph System (SEBASS), Hyperspectral Thermal Emission Spectrometer (HyTES), and MAKO (a SEBASS follow-on) sensors covering the approximately 8 – 14 micrometer range for selected sites were atmospherically corrected and converted to emissivity (and temperature) using both empirical and model-based methods [3] and then analyzed to determine endmembers using the same approach [2]. Endmember occurrence and abundances were then mapped for each dataset individually and in combination using partial unmixing [2]. Individual wavelength range results were also combined and integrated utilizing a variety of clustering and classification approaches [4-6].

3. Results

Independent analysis of the VNIR, SWIR, and LWIR spectral ranges produced a large number of spectral endmembers that could be individually mapped in each dataset. These, however, exhibited complex overlap, indicating that multiple materials/processes exist in each pixel. Integrating the full wavelength range allowed mapping of features derived from the multiple modalities, revealing additional detail and leading to improved characterization and mapping that cannot be accomplished using a single spectral range.

4. References

[1] Matthew, M. W., et al.., "Atmospheric correction of spectral imagery: evaluation of the FLAASH algorithm with AVIRIS data," *Proceedings SPIE,* 5093, 474-482, (2003).

[2] Boardman, J. W. and Kruse, F. A., "Analysis of Imaging Spectrometer Data Using N-Dimensional Geometry and A Mixture-Tuned Matched Filtering (MTMF) Approach," *Transactions on Geoscience and Remote Sensing (TGARS),* 49, 4138-4152, (2011).

[3] Adler-Golden, S. M., et al., "Long-wave infrared surface reflectance spectra retrieved from Telops Hyper-Cam imagery," *Proceedings of SPIE,* 9088, 90880U-1 to 90880U-8, (2014).

[4] Kruse, F. A., "Comparative analysis of AVIRIS and HyTES longwave infrared (LWIR) hyperspectral data for geologic mapping," *Proceedings SPIE D&S,* (2015, in press).

[5] McDowell, M. L., and Kruse, F. A., "Integrated visible to near infrared, short wave infrared, and long wave infrared spectral analysis for surface composition mapping near Mountain Pass, California," *Proceedings SPIE D&S,* (2015, in press).

[6] Cone, S. R., Kruse, F. A., and McDowell, M. L., "Exploration of integrated visible to near-, shortwave-, and longwave-infrared (full range) hyperspectral data analysis," *Proceedings SPIE D&S,* (2015, in press).